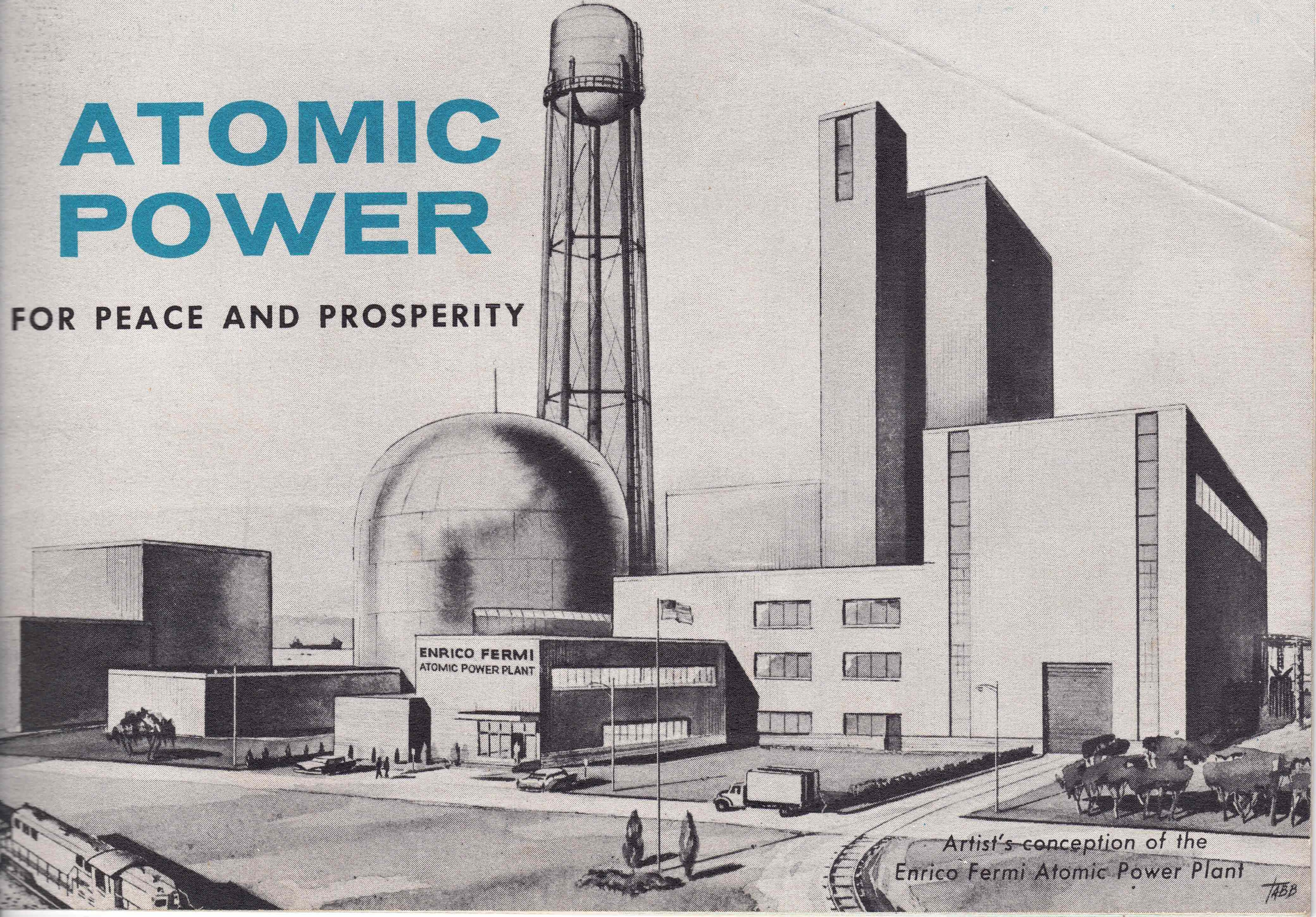
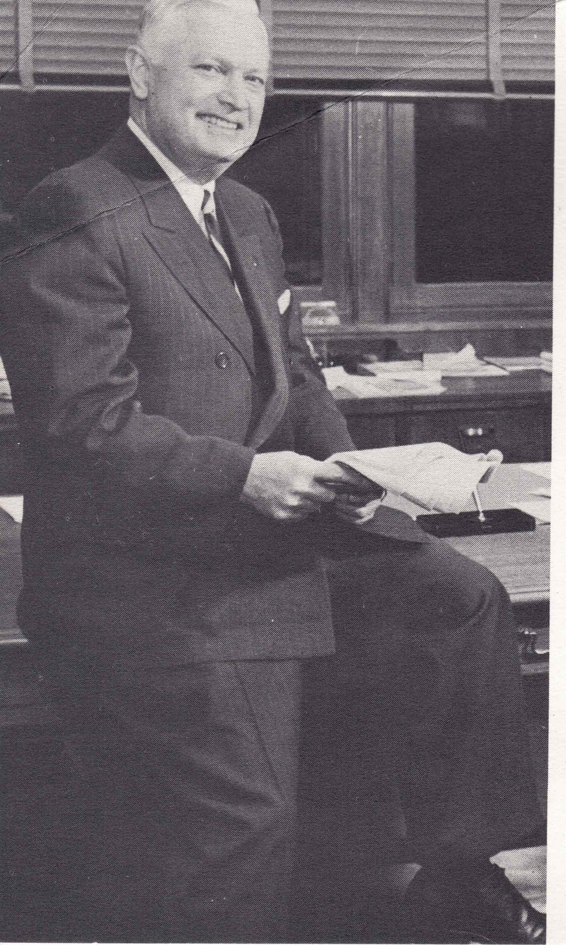
ATOMIC POWER

FOR PEACE AND PROSPERITY



Artist's conception of the Enrico Fermi Atomic Power Plant



April 1, 1960

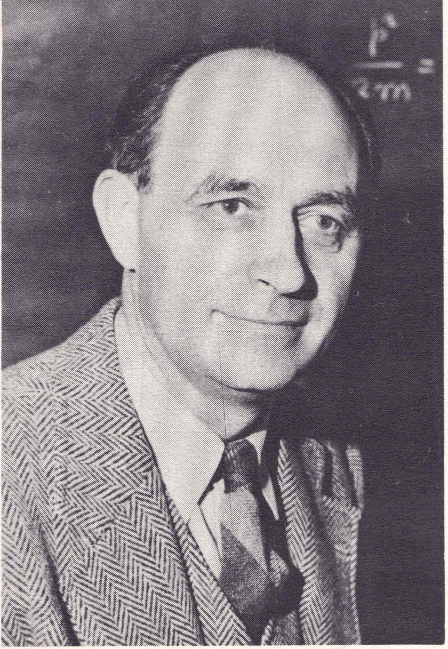
When the Lagoona Beach site near Monroe, Michigan was selected for the Enrico Fermi Atomic Power Plant, there was little in that desolate marshland to suggest a new frontier in the peaceful development of atomic energy. But there, on that Lake Erie shoreline, the men who are designing and building this atomic power plant visualized the growth of a mighty symbol of the Atomic Age . . . a symbol made of steel, concrete and brick that would demonstrate the peaceful use of the atom for the benefit of all.

Since the beginning of construction in August, 1956, rapid progress has been made, both in the building of the physical plant and in the research and development work that keeps well ahead of actual construction.

This booklet tells, very briefly, about the highlights of this action—of private industry's willingness and ability to meet its responsibilities and pioneer in the development of atomic power—and of the cooperation and valuable assistance given the project by the Atomic Energy Commission.

Walker L Cisler

Walker L. Cisler, *President*
Power Reactor Development Company



Dr. Enrico Fermi
1901 - 1954

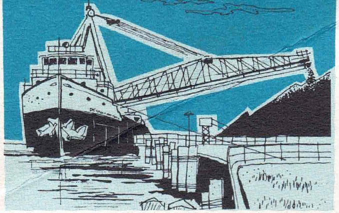
> *"THE COUNTRY which first develops a breeder reactor will have a great competitive advantage in atomic energy."*
>
> *. . . Enrico Fermi . . . at Los Alamos in 1945.*

Michigan's first atomic power plant—the world's largest "breeder" power reactor installation—is named in honor of the late Dr. Enrico Fermi, the famed Italian-American scientist whose pioneering work led to the first controlled release of nuclear energy.

It was at the University of Chicago on December 2, 1942, that Dr. Fermi and his associates accomplished the first self-sustaining nuclear chain reaction. This same controlled chain reaction demonstrated by Dr. Fermi seventeen years ago will produce heat for use in the production of electric power.

Dr. Fermi also was the first to recognize the importance of the breeder principle . . . stating his belief that the first nation to develop the breeder reactor would lead the world in nuclear progress.

It is fitting that at the Power Reactor Development Company's historic inaugural ceremonies on August 8, 1956, the project was named the Enrico Fermi Atomic Power Plant.



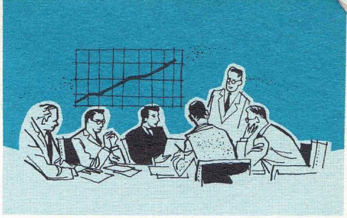
NEED FOR A NEW FUEL

One of the keystones of the basic prosperity of the United States is energy—in the form of abundant, low-cost electric power. With the help of electricity we have been able to increase our productivity tremendously—to earn more in less time and to buy more and better products at lower cost. New industrial applications of power to machines are continually creating better job opportunities. America's ever-improving standard of living is the wonder of the world.

Our need for electric power is growing at such a rapid rate that by 1980, we may be using almost four times as much electricity as we do today. This could mean a comparable increase in the use of precious resources of heat energy—coal, oil and gas—from which about 80 per cent of the nation's electric power is produced. Although this drain on the country's fuel reserves is no immediate threat, it is becoming increasingly apparent that supplies of these key resources cannot last forever. Then too, there is great need to conserve conventional fuels for use as raw materials for the growing steel and chemical industries.

The discovery of atomic fuels—uranium and thorium—makes available a vast new source of energy that can be used in the production of electric power. For example, one pound of uranium contains enough energy to produce more than 3,500,000 kilowatthours of electric power as compared to about 1½ kilowatthours from a pound of coal.

Today, American industry—in cooperation with the U.S. Atomic Energy Commission, educational institutions and others—is speeding work on ways to make atomic power practical and economical. The Enrico Fermi Atomic Power Plant is an outstanding example of a dedicated industry's determination to make the atom a powerful force for the advancement of civilization.



DECADE OF PROGRESS

On the surface it would appear that the Enrico Fermi Atomic Power Plant received its start in the spring of 1956 when site preparation work began. Actually, the project dates back to 1951 and in some respects even earlier.

Four industry study groups were formed in 1951, one of which was the Dow Chemical-Detroit Edison team, forerunner of the organization that in 1955 became known as Atomic Power Development Associates, Inc.

APDA is a non-profit corporation with a membership comprising 30 electric power companies and 12 engineering and manufacturing firms. Together they share the expensive research, experimentation and development work that has been going into the basic design of the fast breeder power reactor and related facilities for the Fermi plant. The group also keeps itself completely informed on other reactor designs. Nationally known authorities on reactor technology serve as consultants.

On January 10, 1955 the Atomic Energy Commission announced its Power Demonstration Reactor Program to accelerate private industry's efforts to develop atomic power and to speed the time when it might compete with conventional methods of generating electricity.

Several months later, on March 31, a proposal for construction of a developmental fast breeder power reactor was filed with the AEC by a group of 9 companies that was formalized the following August as Power Reactor Development Company (PRDC), a non-profit organization.

Today, PRDC's membership represents 18 electric power companies and 7 manufacturing firms associated together for the purpose of financing, constructing, owning and operating an APDA-designed developmental power reactor to advance atomic power development. This is the group that is building the reactor and related nuclear facilities which will go into the Enrico Fermi Atomic Power Plant.

It is expected that this project will be an outstanding contribution to the goal of Atoms-for-Peace for the betterment of all mankind.

WHY THE BREEDER REACTOR

All nuclear power reactors have a common purpose—to release heat energy for use in producing electric power. But only the breeder reactor has the ability to make effective use of all the nuclear materials in its fuel cycle—rather than only the fuels enriched with the costly fissionable isotope U-235 extracted from natural uranium.

Natural uranium is plentiful and inexpensive but contains only 0.7 of one per cent of the fissionable U-235. The remaining 99.3 per cent is Uranium-238 which is non-fissionable and has no fuel value.

The breeder reactor has the ability to change this U-238 into a new atomic fuel—plutonium (Pu-239)—while the reactor is performing its normal operation of producing heat energy. With the solution of a number of complex metallurgical problems, this man-made plutonium may be used, instead of U-235, as reactor fuel material.

The breeder reactor for the Fermi plant is expected to produce about 20 per cent more fuel in the form of plutonium than it uses in the form of U-235. It will therefore conserve and add to the nation's nuclear fuel reserves rather than deplete these resources.

The Fermi reactor is the same type as the Experimental Breeder Reactor (EBR-1) designed and built by the AEC's Argonne National Laboratory—which was the first reactor known to produce usable quantities of electric power from atomic energy. The EBR-1 also demonstrated the principle of breeding nuclear fuel and the operating stability of sodium-cooled heat transport systems.

An important objective of the fast breeder research and development programs now under way is the improvement of fuel cycles and heat transport systems. Studies and experiments which have been made to date indicate that a second generation fast breeder power reactor, incorporating such improvements, can be built and operated as safely and economically as any modern conventional power plant of today. Experience gained in operating the Fermi plant is expected to verify these conclusions.

The simplified drawing on the opposite page shows the arrangement of components in the sodium-cooled breeder reactor being built for the Enrico Fermi Atomic Power Plant.

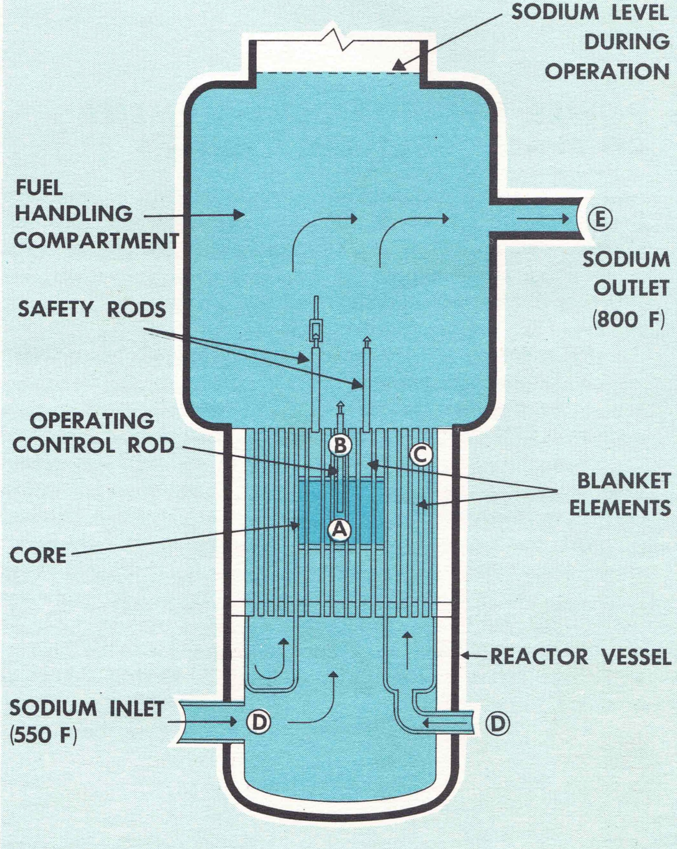
ARRANGEMENTS OF REACTOR COMPONENTS

This schematic drawing of the breeder reactor shows the arrangement of major components. Most of the heat and some of the new fuel (plutonium) is produced in the core (A).

The core is an assembly of thin rods containing an enriched grade of uranium, the atoms of which can be made to fission, or split. When the control rods (B) are adjusted, neutrons bombard the core and the fissioning process (atom-splitting) takes place. The core is silent in its operation—no combustion takes place—there is no flame. Yet large amounts of heat are released as the splitting atoms give up their energy.

Surrounding the core is a two-foot-thick assembly referred to as a blanket (C) containing a lower grade of uranium that is non-fissionable—but fertile, i.e. capable of being made fissionable. It is here that most of the new fuel is produced by neutrons being absorbed in the blanket material. This action changes the material into a new man-made atomic fuel which can be fissioned—plutonium.

Heat-energy is removed from the core and blanket by circulating a liquid metal, sodium, which enters at (D) and leaves the reactor at (E).



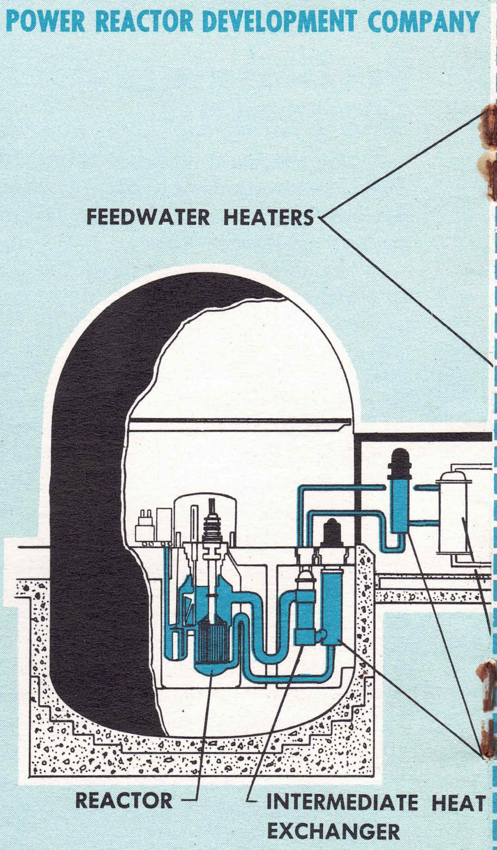
POWER REACTOR DEVELOPMENT COMPANY FACILITY

The drawing on these two pages presents a cross-section of Enrico Fermi plant, which should be completed and ready for initial nuclear operation in late 1960. Power Reactor Development Company is designing and building the reactor section shown on this page. PRDC will own and operate this section, the construction cost of which is expected to reach $42 million.

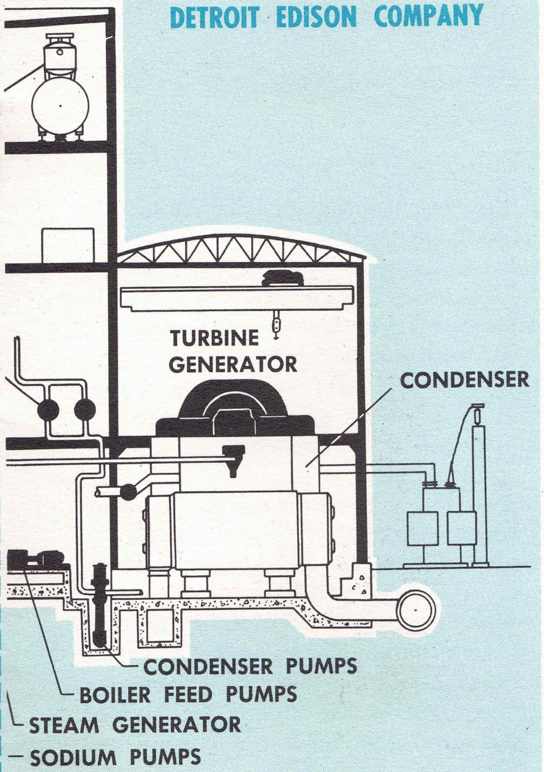
Expenditures by Atomic Power Development Associates on research, development and reactor components should reach about $18 million by the time the plant is ready for full power operation. An additional $2½ million for such services has been budgeted by PRDC.

With the exception of $4,450,000 of research and development work being performed in Atomic Energy Commission laboratories, the capital cost of the Fermi plant is financed entirely with private funds.

The reactor, as indicated in this drawing, is only part of the atomic power plant—a new kind of furnace for turning out heat. Heat from the reactor is carried by molten sodium to heat exchangers and then transferred to secondary sodium systems that carry the heat out of the reactor building to steam generators. Here the heat changes water into steam which PRDC will sell to Detroit Edison for the production of electricity.



DETROIT EDISON COMPANY



DETROIT EDISON FACILITY

The steam generated by heat released in the reactor will be utilized in a conventional steam-turbine generator very much like those in coal-burning power plants in general use around the nation. The condensers, pumps and control devices and other equipment also are similar to those now in use.

The electric power generating facilities of the Fermi plant which will be built, owned and operated by The Detroit Edison Company are depicted on this page. This section of the plant—costing in the neighborhood of $17,000,000—will house a 150,000-kilowatt steam turbine-generator and auxiliary equipment.

After suitable preliminary testing, and a careful startup procedure, steam purchased from Power Reactor Development Company will permit Detroit Edison to generate 100,000 kilowatts of electricity. Later, the reactor's steam output should be capable of operating the turbine-generator at its full capacity of 150,000 kilowatts.

The electric power produced—no different from that generated by coal-burning power plants—will be transmitted over existing lines to homes, stores, farms and factories to make life better—electrically.

RESEARCH AND DEVELOPMENT

Research and development on the Fermi project, which has been the responsibility of APDA, has received the guidance and advice of widely recognized nuclear engineers and scientists. These experts share the confidence of the project's designers and builders that the reactor will perform as expected and will be safe beyond any reasonable doubt.

Much work lies ahead, however, before atomic power becomes practical or economical in regard to cost. To find better routes to commercial atomic power, extensive research, development and testing programs are being conducted by APDA, PRDC and their consultants and contractors. In addition, the assistance of outstanding Atomic Energy Commission scientists has been arranged through the AEC's Power Demonstration Reactor Program as well as the use of excellent testing facilities in government laboratories.

One of the most important research programs was done for PRDC by the Argonne National Laboratory in a critical assembly test which provided essential information on the nuclear physics of the reactor design—critical mass, control characteristics, power distribution and other data of equal value.

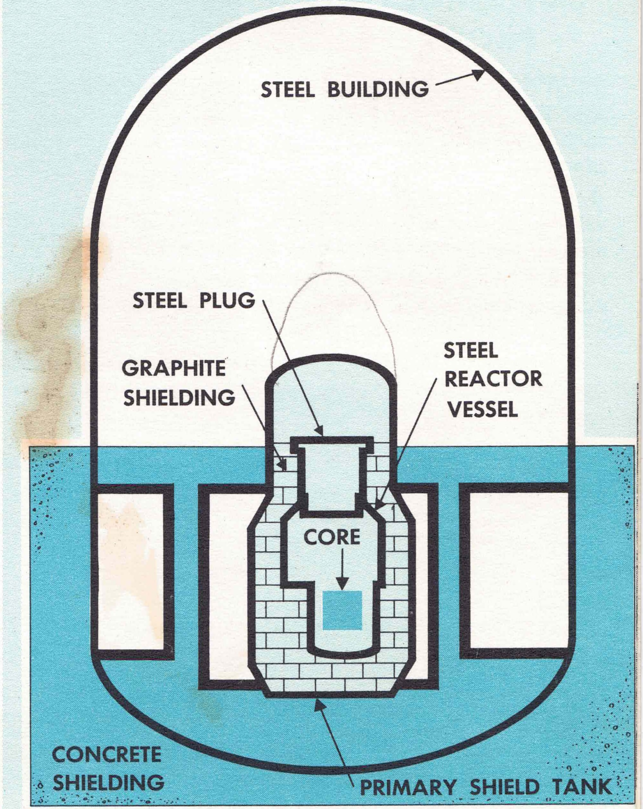
APDA has installed the reactor vessel and associated equipment and will operate it as a test facility in the Fermi reactor building. One full year will be devoted to mechanically testing full-scale reactor components under operating conditions. APDA will be responsible for the nuclear phase of the pre-operations and operational testing of the completed reactor section. No atomic fuel will be used until the entire installation has been thoroughly tested and meets the AEC's rigid health and safety requirements.

When the Fermi project is completed in 1960, private industry will have made another big contribution to the nation's expanding nuclear technology and atomic leadership.

SAFETY SHIELDS

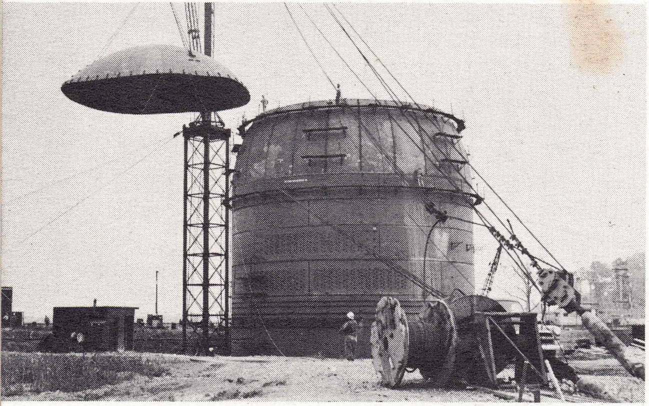
The health and safety of the public and plant personnel will be protected according to the strictest industrial standards by five fundamental safety shields.

1. The reactor mechanism is inherently self-regulating and will be equipped with automatic safety and limit controls. In addition, the fuel elements are "clad" with zirconium, a highly melt-resistant metal.
2. The reactor vessel, of thick stainless steel, encloses all radioactive fuel materials and is sealed with a 150-ton steel plug.
3. A steel primary shield tank furnishes another protective barrier.
4. Steel-lined concrete shielding supports and surrounds the reactor's primary shield tank.
5. The steel reactor building with its gas-tight dome encases the entire assembly both above and below ground and is designed to withstand high internal pressures.

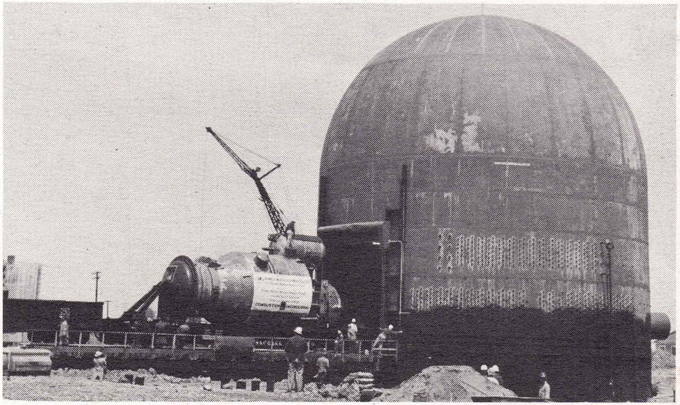


CONSTRUCTION PROGRESS

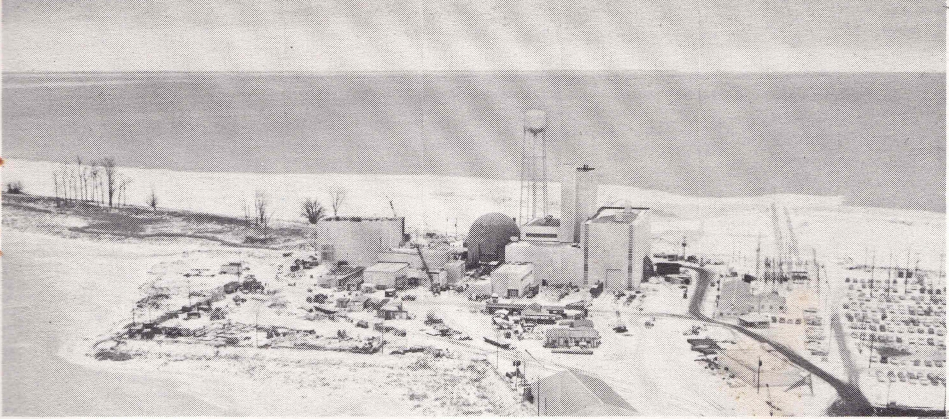
Aerial view of the Enrico Fermi Atomic Power Plant site taken in June 1956, after one month of filling operation. Nearly 40 per cent of the 915-acre site was originally marshland or entirely submerged. Filling the 12-acre plot on which the plant is being built was completed in August 1956.



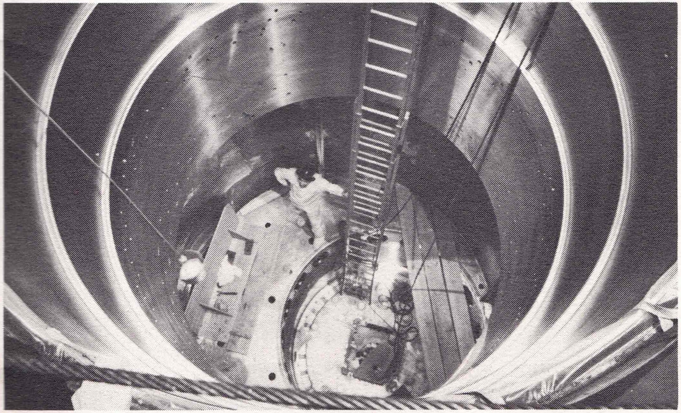
The reactor building was completed in September, 1957. The steel structure has now undergone two pressure tests at 40 pounds per square inch to assure airtightness and strength.



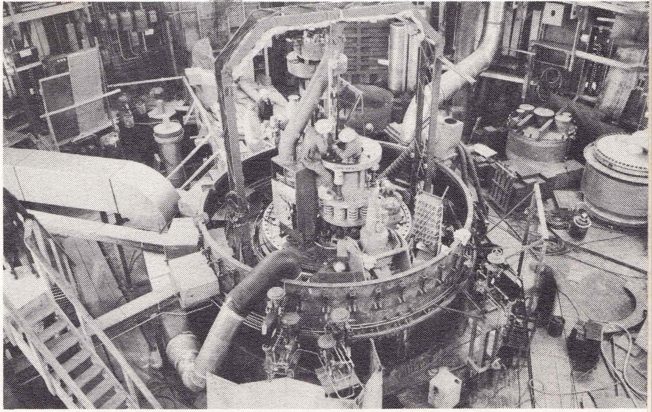
The 91-ton stainless steel reactor vessel---heart of the Fermi plant---arrived at the site in May, 1958. Built in Chattanooga, Tennessee, the vessel traveled 1,600 miles by barge and rail.



Michigan's Lake Erie shoreline now has a new and growing landmark --- a symbol of the atomic age and tangible evidence of the rapid strides being made by industry toward America's goal of Atoms-for-Peace.



Technician, garbed in lint-free coveralls to keep reactor vessel clean during construction, is shown working inside the "atomic furnace" which is 14 feet wide, 36 feet high.



View of reactor building interior showing fuel handling and control equipment being positioned on top the reactor vessel. One of the sodium pumps and heat exchangers is on the right.

TECHNICAL DATA

PLANT CAPACITY	**100,000 kilowatts**

REACTOR

Power (heat)	300,000 kilowatts
Critical mass (U-235)	444 kilograms
Breeding ratio	1.2
U-235 consumed per year	87 kilograms
Plutonium produced per year	106 kilograms
Fuel alloy	U—10% Mo
Uranium enrichment	25.6%
Core diameter	30.5 inches
Core length	30.5 inches
Core average heat flux	652,000 Btu/hr.-sq. ft.
Core power density	78,500,000 Btu/hr.-cu. ft.
Sodium velocity	31.2 ft./sec.
Over-all height of primary shield tank—over dome	56.3 ft.
Height of primary shield tank	40.2 ft.
Maximum diameter of primary shield tank	24 ft.
Height of reactor vessel	36.3 ft.
Maximum diameter of reactor vessel	14.5 ft.
Maximum vessel thickness	2 inches

LIQUID METALS AND STEAM PLANT

Net thermal efficiency	31.3%
Primary sodium temperatures	
Entering reactor	550 F.
Leaving reactor	800 F.
Sodium flow	13,200,000 lb./hr.
Secondary sodium temperatures	
Entering steam generator	750 F.
Leaving steam generator	500 F.
Steam pressure	600 psia
Steam temperature	740 F.

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- Babcock & Wilcox Company, The
- Burroughs Corporation
- Central Hudson Gas & Electric Corporation
- Cincinnati Gas & Electric Company, The
- Columbus and Southern Ohio Electric Company
- Combustion Engineering, Inc.
- Consumers Power Company
- Delaware Power & Light Company
- Detroit Edison Company, The
- Fruehauf Trailer Company
- Holley Carburetor Company
- Iowa-Illinois Gas and Electric Company
- Long Island Lighting Company
- Philadelphia Electric Company
- Potomac Electric Power Company
- Rochester Gas & Electric Corporation
- Southern Services Inc., representing:
    - Alabama Power Company
    - Georgia Power Company
    - Gulf Power Company
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- Central Hudson Gas & Electric Corporation
- Cincinnati Gas & Electric Corporation
- Cleveland Electric Illuminating Company, The
- Commonwealth Associates, Inc.
- Connecticut Light & Power Company, The
- Consolidated Edison Company of New York, Inc.
- Consolidation Coal Company, Inc.
- Consumers Power Company
- Delaware Power & Light Company
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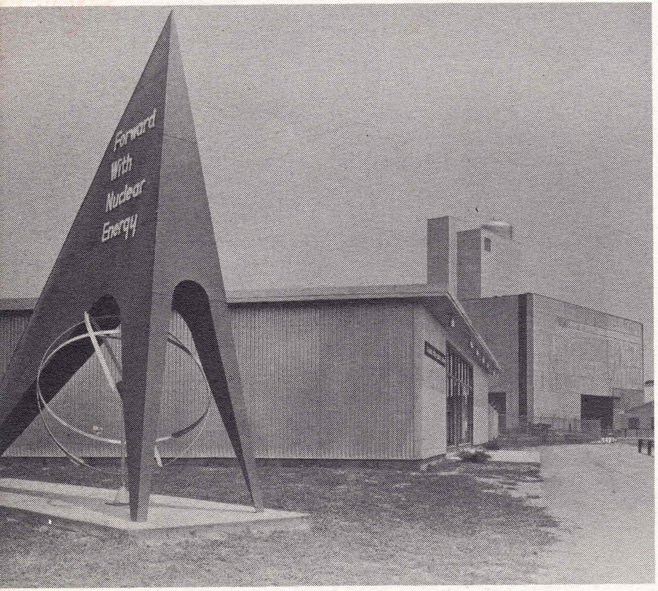

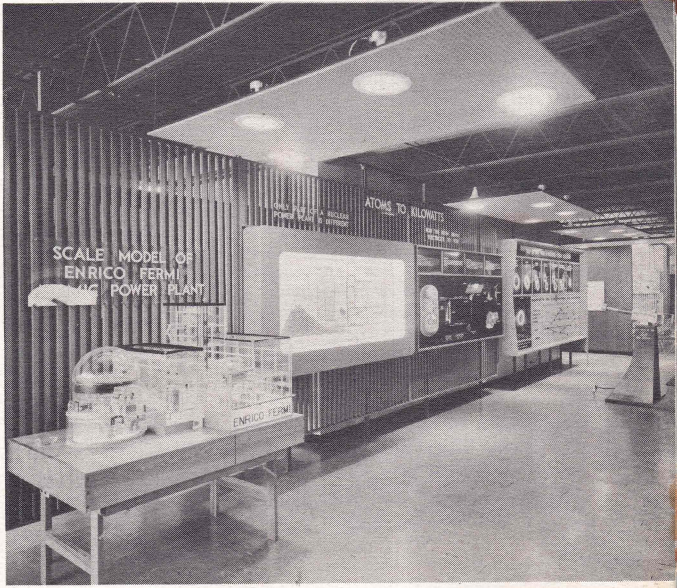

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